SCOR WG #169 GLUBS

1. Brief summary with the main highlights (200-300 words)

Since being inducted as a working group in November 2023, the Global Library of Underwater Biological Sounds (GLUBS) has had a productive start toward achieving our proposed terms of reference. Within GLUBS, sub-working groups have continued to meet separately to work towards their respective assignments for the ToRs, in addition to several large group meetings. Two workshops were held on annotation standardization, consisting mostly of GLUBS members, but also included several outside experts in the field.

We expect this effort to result in a peer-reviewed publication soon, adding to our three publications in the last year (Parsons et al. 2023, Looby et al. 2023, Jarriel et al. 2024). These have contributed to several of our ToRs, notably 1 and 7. We also expect to have a perspective piece on current AI practices in bioacoustics published in the coming months. As listed in our ToRs, GLUBS aims to inspire others to also investigate unknown sound detection and characterization. Our Frontier's research topic on this subject has currently received 8 submissions, with several more in preparation.

On top of movement on the scientific front, GLUBS has taken large strides in outreach and establishing its presence in the bioacoustics community. We have presented GLUBS at several conferences, including ASA Australia, OSM USA, UNDOS, ASA Ottawa, and the World Ecoacoustics Congress, through talks, posters, small sessions, or satellite events.

Finally, we have had tremendous success with the outreach surrounding our second World Oceans Passive Acoustic Monitoring (WOPAM) Day, with more than 400 planned recording sites from over 100 different contributors. In the lead up to this event, WOPAM and GLUBS were featured on numerous social media platforms (X and Facebook) and news channels (Channel 7 and ABC radio in Australia).

2. Activities since previous report to SCOR (e.g., virtual or in-person meetings, email discussions, special sessions). Limit 1000 words

Within GLUBS' 5 sub-working groups (Cyberinfrastructure, Artificial Intelligence (AI), Unknown Sounds, Marine Mammal Sounds, and Public Outreach), there have been numerous meetings within working groups, as well as several between working groups. Every month the co-chairs, along with two other key members, have met to keep GLUBS moving forward, identify and write funding proposals, and provide updates on the different moving parts.
The Cyberinfrastructure group met in December (building on meetings before GLUBS became a WG), to further its progress on the dataset of existing tools and resources in underwater bioacoustics.
The AI group has had multiple meetings, at the end of August 2023 and early June 2024 to begin outlining their paper on the current best practices in AI.
The Outreach group met once to discuss plans for social media outreach, including creating a Facebook and giving more GLUBS members access to the X (formerly Twitter) account for more regular posts.
One large cross-working group meeting was held (September), with email discussion follow-up, to identify case-studies for GLUBS AI and unknown sound categorization going forward. Another large

group meeting with the official SCOR members was held in July to recap the year, delegate ToR deliverables, and plan for next year.
Two workshops were hosted in April and May, with perspectives and presentations from experts both within and outside of GLUBS, to discuss best practices and current methods for sound annotation for AI. The participants of these workshops are collaboratively working up a manuscript to be submitted to a peer-reviewed journal.
The Unknown Sounds and Marine Mammal Sounds working groups have not had any formal meetings yet, instead communicating via email discourse so far, but are expected to play a bigger role in GLUBS developments in the coming 2 years.

3. Documents published since previous report to SCOR (e.g., peer-reviewed journal articles, reports, Web pages) and should be limited to publications that resulted directly from WG activities and which acknowledge SCOR support

In the last 9 months, GLUBS has produced two peer-reviewed journal articles and one Zenodo dataset published, acknowledging SCOR's support. Two more papers are in preparation and are expected to be submitted in the next couple of months.

- Parsons et al. (2023) summarized the in-person GLUBS WG discussion held at The Effects of Noise on Aquatic Life 2022. This paper was valuable in progressing the goals of GLUBS and establishing itself in the scientific community.

- Looby et al. (2023) created an inventory of species confirmed to produce sound underwater, and connected this to the World Register of Marine Species (WoRMS) as a searchable trait. Publishing this literature review and dataset directly fulfilled part of the first proposed ToR and will be continuously updated as new research on underwater sonifery comes out.

- Jarriel et al. (2024) was one of the results of the large GLUBS WG in-person meeting in 2023. Building on previous efforts, literature searches, and group discussions, we collated comprehensive lists of existing underwater sound repositories, aquatic sound libraries, and tools and resources for sound processing. This was published as a dataset on Zenodo and added as searchable lists on our website (glubs.org) for acousticians and beginners alike to peruse and learn more about resources available. Furthermore, this informs GLUBS of the niche in underwater sound storage and processing that remains to be filled, and the tools already available to help it accomplish this. Jarriel et al. (2024) and Looby et al. (2023) were both led by early career scientists.

In progress, we have one perspective paper on the current state and best practices in AI and a paper summarizing the two labeling workshops hosted this spring and recommending practices for annotation for AI. The first will be led by our AI team, to address ToR #5 and lay the foundation for GLUBS AI. The second will be led by an early career scientist, with input from multiple research groups working on sound annotation for AI, all with very different approaches and end goals.

4. Progress toward achieving group's terms of reference. List each term of reference separately and describe progress on each one. Limit 1000 words

1. **Inventory of soniferous species** – *promised deliverables: Up-to-date species list available on WoRMS, Publication on new species identified as soniferous between 2023 and 2026*

   The publication of Looby et al. (2023) in Scientific Data achieved the first part of this ToR, successfully documenting confirmed and expected underwater soniferous behaviour for more than 34,000 aquatic species of fishes, mammals, reptiles, amphibians, molluscs, and birds. Further, by collaborating with the WoRMS database, this information is highly accessible and able to be updated, which the authors of this paper plan to do in the following years.

2. **Mammal sounds library** – *promised deliverables: Publication of categorized underwater sounds of aquatic mammals by species, geographic location and time*

   Limited progress has been made on this ToR to date, but it will be a priority in the next two years. The last online WG meeting (July 2nd) was instrumental in highlighting the need for attention to this ToR and resulted in several WG members coming forward to get involved with it. It was also a topic of discussion to utilize funds to support a meeting of the marine mammal sounds group, perhaps as a workshop in conjunction with LAMLA (Listening for Aquatic Mammals in Latin America).

3. **Standardised method to categorise sounds** – *promised deliverables: Peer-reviewed article on a standard method to characterize sounds*

   Two workshops with experts in the sound annotation field have been held thus far, and will result in a peer-reviewed paper on best practices for sound annotation for AI (in progress). This will meet the first aspect of this ToR, and then we expect to do a similar workshop and publication follow-up on sound characterization.

4. **Unknown sounds library** – *promised deliverables: Research Topic compilation of papers on unidentified sounds in Frontiers in Remote Sensing, including an editorial synopsis, Editorial article on unidentified sounds in general science magazines*

   The research topic in Frontiers is on-going with a deadline of September 1, 2024, with 9 papers published or in review thus far, and several more planned to be submitted. Once closed, this research topic will be converted to an e-book if 10 or more papers are accepted (expected) with a GLUBS-authored editorial synopsis to accompany the papers.

5. **Develop AI tools to detect biological sounds –** *promised deliverables: Open access dataset and accompanying publication on the use of AI detection algorithms to assess a fish community, A collection of annotated open access datasets for the machine learning community to test their algorithms, Papers outlining a variety of AI detection algorithms*

   After several AI working group and cross-working group meetings, the order for tackling this ToR has been adjusted slightly. A perspective paper on AI for sound detection will be the first goal to identify best practices and state-of-the-art algorithms for GLUBS AI. This paper is currently in progress and expected to be submitted to a peer-reviewed journal before the end

of the year. We are also in the process of developing pilot test sets of sounds, primarily fish, from two different GLUBS collaborators. These first datasets, on Mediterranean fish and Caribbean coral reef sounds, will be displayed on our website and utilized to train and test detection algorithms on. The case study will be pushed to the 2nd and 3rd years.

6. **Promote awareness of underwater sound –** *promised deliverables: A synopsis of media materials produced to promote awareness of aquatic sound*

   GLUBS has had numerous initiatives and opportunities to promote the importance of underwater sound since becoming a SCOR WG. In addition to presentations at several scientific conferences and feature in a World Ecoacoustics Congress plenary speech, GLUBS has:

   - Co-hosted the satellite event, 'Listen to the Ocean', at the UN Decade of Ocean Science in Barcelona. This week-long event, held in a venue less than 200 m from the main conference, focused on the importance of sound in the sea, with multiple perspectives presented by the co-hosts. Many fruitful discussions with conference-goers - scientists and policy-makers alike, resulted, as well as outreach with interested citizens.
   - GLUBS' second World Oceans Passive Acoustic Monitoring (WOPAM) Day (wopam-2024) received much attention, highlighting global collaboration and the importance of aquatic sound. This effort was featured in social media posts either by @GLUBS1 or collaborators (e.g., GLUBS1). The main post received >1.8k impressions on X and 7.5k views on Instagram and the project was covered on Channel 7 News (AU). A video and song, composed of biological sounds from the previous year's WOPAM day, were created to promote the event and the full song placed on YouTube. The number of contributors has continued to build since the previous year, and we plan to continue this momentum into next year, hosting workshops for participants and opening it up to citizen scientists.
   - The Australian Broadcasting Corporation and GLUBS co-organised a special five-episode 'Noi-SEA by Nature' podcast series (noisy-by-nature) that is targeted for children and explores the world of underwater sounds produced by aquatic fauna. Each episode was co-hosted by a different bioacoustician and the series was released on World Ocean's Day (anticipated reach for this series estimated through social media engagements was above 50k).

7. **GLUBS cyberinfrastructure** – *promised deliverables: Publication and webpage outlining existing applications relevant to underwater bioacoustics and GLUBS, Report on the required infrastructure to implement GLUBS libraries*

   The first promised deliverable for ToR #7 has been achieved, with the publication of existing applications in underwater bioacoustics as a dataset on Zenodo (Jarriel et al. 2024). They have also been integrated as searchable lists on our public website (glubs.org). The next two years will address the infrastructure required for GLUBS and potential funding for permanent hosting and storage.

5. WG activities planned for the coming year. Limit 500 words

The GLUBS WG plans to continue meeting virtually, this upcoming year, while we explore the best option for the next large in-person meeting. Individual working groups will continue meeting online to work towards their goals.

Two publications are planned for the coming year, one from the GLUBS AI group and one on annotation best practices. Further, we plan to begin working on two more this year: sounds of aquatic mammals and categorization of unknown sounds. The aquatic mammal sounds paper will likely require a workshop of experts in the field to get it off the ground, we are considering holding this at the upcoming African Bioacoustics Community conference (South Africa, September 2024) or similar, or collaborative working on the later stages at LAMLA (2026).

The Frontiers research topic will be closed in September 2024 and we will produce an accompanying editorial synopsis for the book.

We hope to have at least two open-source datasets of sounds (unknown and known) to use as AI test sets and display on our website in 2025.

Finally, we will continue the momentum of WOPAM day and host at least one workshop for participants this year, produce a report on the findings thus far, and continue expanding and spreading awareness for WOPAM Day 2025.

6. Is the group having difficulties expected in achieving terms of reference or meeting original time schedule? If so, why, and what is being done to address the difficulties Limit 200 words

The Marine Mammal Sounds sub-working group of GLUBS has had some initial challenges getting going, due to time constraints and lack of additional funding. However, at the last larger group meeting, several other GLUBS members stepped up to help accomplish the sub-working group's tasks. This will help take the weight off just a few people and hopefully help get the momentum going. We have also discussed using SCOR funding to get the marine mammal group together in person, possibly in conjunction with a workshop on the topic, to get the initiative off the ground.

7. Any special comments or requests to SCOR. Limit 100 words.

Additional information can be submitted and may be posted at the SCOR Annual Meeting webpage at the discretion of the SCOR Executive Committee Reporter for the WG and the SCOR Secretariat.